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## **THE NOMENCLATURE OF KANSAS COAL-MEASURES EMPLOYED BY THE KANSAS STATE GEOLOGICAL SURVEY.**

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**Y**EARS ago the Kansas State Geological Survey began a systematic study of the detail stratigraphy of eastern Kansas. Largely because the existence of the Survey depended upon biennial appropriations, preliminary reports were made. Naturally such reports were somewhat defective. Geologists in the neighboring states, Missouri, Iowa, and Nebraska, have taken up the matter in a way largely by criticism of Kansas, rather than by giving details of conditions in their own states, with the result that there is now in print, widely scattered through magazines, state and governmental reports, a comparatively extensive literature of the stratigraphy of the Kansas Coal-measures, practically all of which is partly correct and partly incorrect. This condition has been aggravated, wholly unintentionally, through the labors of the United States Geological Survey. This organization has surveyed the Iola quadrangle and Independence quadrangle. An error in stratigraphy was made and published regarding the southwest corner of the Iola quadrangle. Field-work on the Independence quadrangle was conducted and a preliminary report published before this error in the Iola quadrangle was detected, and as a result its influence caused errors to creep into the Independence sheet reports as well.

In the present paper, the stratigraphy of this part of the state is given in great detail, after years of continued work, and it is confidently believed we have finally succeeded in getting all matters straightened out, so that the presentation here offered is a complete and accurate exposition of positions and relations of all alternating beds of limestones and shales, with included sandstones from the bottom of the Lower Coal-measures up to the Burlingame limestone. Every individual limestone has been traced with greatest detail by a personal examination not only of every mile square, but by a geologist following it across every forty-acre tract of land from the north side of the state to the south. In some instances, where

difficulties were greatest, two or more geologists have spent weeks and months tracing such formations a distance of only a few miles.

#### CHEROKEE STAGE.

The Cherokee stage is not yet subdivided, being composed entirely of the Cherokee shales.

CHEROKEE SHALES.<sup>1</sup>—The name Cherokee shales was given by Haworth and Kirk in 1894 to a heavy bed of shales lying at the base of the Coal-measures in Kansas. The name was chosen on account of their prominence in Cherokee county, the southeastern county of the state.

#### MARMATON STAGE.<sup>2</sup>

The Marmaton stage is subdivided into eight parts, namely, the Fort Scott limestone, Labette shales, Pawnee limestone, Bandera shales, Altamont limestone, Dudley shales, Coffeyville limestone, Pleasanton shales.

FORT SCOTT LIMESTONE.—The name Fort Scott limestone is here applied to the two limestone beds occurring at Fort Scott, with about seven feet of shale between, which beds have been traced in detail both southwest and northeast to beyond the state line.

In 1894, Haworth and Kirk,<sup>3</sup> in a preliminary description along the Neosho river, named these rocks Oswego limestone, which name was retained in volumes I and III of the State Survey's reports. In his report on Kansas geology, in 1860, Swallow named the lower one Fort Scott cement rock. Since the first publication of the name Oswego, in 1894, it has been learned that the name was previously occupied by Prosser,<sup>4</sup> who used it in connection with a division of the Silurian in the state of New York. As the name Fort Scott is just as appropriate on account of the rocks being so well exposed in the environs of a city by that name, and partly on account of Swallow<sup>5</sup> having proposed the name for the lower bed, the term is here adopted to replace the name Oswego, previously used by this Survey.

LABETTE SHALES.<sup>6</sup>—The name Labette shales is applied to a bed of shale lying immediately above the Fort Scott limestone.

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1. Haworth & Kirk, *Kan. Univ. Quart.*, vol. II, p. 105, Lawrence, 1894.

2. Haworth, Prof. E., *Kan. Univ. Geol. Surv.*, vol. III, p. 92, Lawrence, 1898.

3. Haworth & Kirk, *Kan. Univ. Quart.*, vol. II, p. 105, Lawrence, 1894.

4. Prosser, Prof. Chas. S., *Bull. Geol. Soc. Amer.*, vol. IV, pp. 100, 108, 116, 1892.

5. Swallow, Prof. G. C., *Geol. of Kan.*, p. 25, Lawrence, 1866.

6. Adams, Dr. Geo. I., *Kan. Univ. Geol. Surv.*, vol. III, p. 36, Lawrence, 1898.

The term was first used by Adams while the manuscript of volume III was in preparation. Previously Haworth and Kirk<sup>7</sup> had suggested the name Laneville shales in their preliminary report on the geological section along the Neosho river.

**PAWNEE LIMESTONE.**<sup>8</sup>—The name Pawnee limestone was given by Professor Swallow to the limestone first overlying the Labette shales, largely developed along Pawnee creek, in Bourbon county.

**BANDERA SHALES.**<sup>9</sup>—The name Bandera shales is here applied to the shale-bed lying above the Pawnee limestone and below the Altamont. It was at one time called the Lower Pleasanton shales, but, as will be explained farther on, this nomenclature was dropped.

**ALTAMONT LIMESTONE.**<sup>10</sup>—The name Altamont limestone is here applied to the limestone at Altamont, the schoolhouse at that place being built immediately on top of it. This name was first used by Adams in volume I of this series of reports. It is also described by Bennett<sup>11</sup> in volume I, being spoken of as the "eight-foot system" lying within the Pleasanton shales, showing that it is sufficiently persistent to be recognized at that time as dividing the Pleasanton shales.

Later Adams<sup>12</sup> withdrew the name Altamont and substituted the name Parsons for the same formation. In his later description he speaks of it as consisting of two members. Subsequent work by this Survey has shown conclusively that he was in error and that the upper limestone is one so prominent at Coffeyville, which is designated as the Coffeyville limestone. Why he should have changed the name from Altamont to Parsons with no apparent reason is entirely unknown. As Altamont has already appeared in volume I of our geological reports, of course we are under the necessity of retaining the name, and this is particularly desirable on account of its eminent appropriateness.

**WALNUT SHALES.**—The name Dudley shales was applied by Adams<sup>13</sup> to a bed of shales described as follows: "The name Dudley shales is here applied to the beds occupying the interval

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7. Kan. Univ. Quart., vol. II, p. 108, Lawrence, 1896.

8. Swallow, Prof. G. C., Geol. of Kan., p. 24, § 203, Lawrence, 1866.

9. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, Washington, 1903.

10. Adams, Dr. Geo. I., Kan. Univ. Geol. Surv., vol. I, p. 22, Lawrence.

11. Bennett, Rev. John, Kan. Geol. Surv., vol. I, p. 94, Lawrence, 1896.

12. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 33, Washington, 1903.

13. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 34; also Bull. 238, p. 17, Washington, 1903.

between the Parsons limestone and the Hertha limestone, which, as explained above, in the discussion of the synonym, are the equivalent of Haworth's Lower Pleasanton shales." We apply the name Walnut for a portion covered by Adams's name Dudley, for the following reasons: *First*. The town of Dudley does not rest on these shales at all, but on the Ladore shales, named by Adams, which name we adopt, and which lie above the Bethany Falls limestone. *Second*. Adams, under the name Bandera shales, says, page 32: "These shales are the equivalent of the Lower Pleasanton shales of Haworth." This latter statement is correct, making the statement that the Dudley shales correspond to Haworth's Lower Pleasanton shales impossible. *Third*. We want a name for the shale-beds above the Altamont limestone and below the Coffeyville limestone, but Adams did not recognize the Coffeyville limestone, so spread the name from the Altamont to the Bethany Falls limestone, thereby crowding out Haworth's Lower Pleasanton shales, which, by all the laws of priority, should be retained. The name Walnut shales, therefore, is applied by us to the shales above the Altamont limestone and below the Coffeyville limestone.

COFFEYVILLE LIMESTONE.—The name Coffeyville limestone is here used for the first time. It is applied to the limestone so prominent at Coffeyville, from which place it takes its name. It is the limestone spoken of as the Upper Altamont or Parsons by Adams,<sup>14</sup> whose error was due to a lack of detailed information. Since his last publication on the subject, this limestone has been traced with great detail by Bennett, who has been able to determine without question that it is a separate limestone formation extending entirely across the corner of the state. Its independent existence warrants us in giving it a distinct name.

PLEASANTON SHALES.<sup>15</sup>—The term Pleasanton shales was first introduced by Haworth in 1895. At that time it was applied to the entire mass of shales lying above the Pawnee limestone and what was then called the Erie limestone, the lower member of which was called the Bethany Falls limestone, and will so appear in our next volume. The intervening Altamont and Coffeyville limestones were not known at that time.

It should be noted that Professor Swallow, in his report for

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14. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 33, Washington, 1903.

15. Haworth, Prof. E., Kan. Univ. Quart., vol. III, p. 274, Lawrence, 1895.

1866, gave no name for either the Bandera, the Dudley or the Pleasanton shales, and, as best we can determine by a careful study of his report, they correspond to the lower part of his Marais des Cygnes coal series, probably from his numbers 178 to 202 inclusive, but we are somewhat in doubt on this subject.

POTTAWATOMIE STAGE.<sup>16</sup>—The Pottawatomie stage is divided into thirteen subdivisions, namely, Bethany Falls limestone, Ladore shales, Mound Valley limestone, Galesburg shales, Dennis limestone, Cherryvale shales, Drum limestone, Chanute shales, Iola limestone, Lane shales, Allen limestone, Vilas shales, Stanton limestone.

BETHANY FALLS LIMESTONE.—The name Bronson Formation was used by Adams<sup>17</sup> to designate the combination or assemblage of three distinct limestone formations which are definitely marked in the southern part of the state, but which come close together on the north by the thinning of the interbedded shales, so that from the middle of eastern Allen county northeastward they appear in the escarpments as one limestone with thin shale-beds between them. These limestones have caused more discussion and confusion than any other formations in the state. In his report in 1866, Swallow confounded them with a number of overlying limestone formations, called them in places Well Rock series, and again the Spring Rock series, and again included them in his Marais des Cygnes coal series.

When the Kansas Survey first began investigations, Bennett ran a geological section west from Fort Scott and encountered these three limestones in the prominent escarpment near Uniontown. He recognized two shale partings and therefore spoke of the limestone as forming a "triple system," which term was used by him provisionally in volume I because exact correlations were not definitely known. Later, Haworth and Kirk named them the Erie limestone, on account of their prominent development northwest of Erie. Still later, Adams gave names to the three individual limestone formations as they occur to the south, and as above stated, suggested the name Bronson formation for their combination on the north, inasmuch as the name Erie was previously occupied.

In 1872,<sup>18</sup> Broadhead gave the name Bethany Falls limestone to a limestone formation which, in his general section, is num-

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16. Haworth, Prof. E., Kan. Univ. Geol. Surv., vol. III, p. 93, Lawrence. 1898.

17. Adams, Dr. Geo. I., U. S. G. S. Bull. 238, p. 17, Washington, 1903.

18. Broadhead, Dr. G. C., Mo. Geol. Surv. Rep., 1872, part II, pp. 76-99.

bered 78, and described it as occurring on the south bank of the Missouri river at the end of the Hannibal bridge, Kansas City, and at a number of places in the north part of the state. The abutment on the south end of the Hannibal bridge rests directly on this limestone, and the Missouri Pacific tracks between the bridge abutment and the river also rest upon the upper surface of this limestone.

Recent investigations by this Survey have demonstrated conclusively that the Bethany Falls limestone of Broadhead, his number 78, is the lower member of Adams's Bronson limestone, of the "triple system" of Bennett, and of the Erie limestone of Haworth and Kirk. Priority requires, therefore, that the term Bethany Falls be used to designate this lower limestone formation. It will therefore replace the name Hertha limestone of Adams,<sup>19</sup> which term, by Adams's recommendation, has, in general, been accepted by the United States Geological Survey and used in their Bulletin No. 238, page 18.

LADORE SHALES.<sup>20</sup>—The name Ladore shales is used by Dr. Geo. I. Adams to designate the shales lying between the Bethany Falls limestone below and the Mound Valley limestone above. It is now used with that significance.

MOUND VALLEY LIMESTONE.<sup>21</sup>—The name Mound Valley limestone was used by the Kansas Survey in volume I of their reports at the suggestion of Doctor Adams, who, at that time, was one of the field assistants. Later, Adams<sup>22</sup> abandoned this name and introduced in its stead the name Dennis limestone, without giving any reason for so doing. His writings, however, show that he confounded the Mound Valley limestone with the one first above, or, rather, he recognized only three of the four limestones occurring here, and therefore dropped one name. This Survey still uses the name Mound Valley, as it did originally, to designate the limestone of the hills immediately northwest of Mound Valley.

GALESBURG SHALES.<sup>23</sup>—The name Galesburg shales was proposed by Adams to designate, as he put it, "the rocks occupying the interval between the Hertha limestone and the Dennis limestone." As has already been shown, Adams in some way overlooked the existence of the Mound Valley limestone, which

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19. Adams, Dr. Geo. I., U. S. G. S. Bull. 238, p. 35, Washington, 1903.

20. Adams, Dr. Geo. I., U. S. G. S. Bull. 238, pl. II, 1904.

21. Adams, Dr. Geo. I., Kan. Univ. Geol. Surv., vol. I, p. 23, Lawrence, 1896.

22. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 36, Washington, 1903.

23. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 36, Washington, 1903.

separates into two parts the shale-beds he referred to. For the shales below the Mound Valley limestone we have already accepted Adams's name, Ladore shales. It is here proposed to retain the name Galesburg shales for those lying above the Mound Valley limestone and below the Dennis limestone.

**DENNIS LIMESTONE.**<sup>24</sup>—Adams used the name Dennis limestone to designate a limestone formation immediately underlying the little way station on the railroad between Parsons and Cherryvale.

As explained above, he confounded these with the Mound Valley limestone, so that, so far as his writings are concerned, the name is equally applicable to each formation. As the name Mound Valley had already been used by this Survey, it was retained with its original significance and the term Dennis, out of courtesy to Adams, is now used for the upper one of the two to which he applied it.

**CHERRYVALE SHALES.**<sup>25</sup>—The name Cherryvale shales is used to designate the shale-bed with the Dennis limestone lying below and the Drum limestone lying above.

**DRUM LIMESTONE.**<sup>26</sup>—The name Drum limestone was first suggested by Adams to designate the limestone covering the hilltops at Cherryvale and occurring in such abundance in the vicinity of Independence. Previously, Haworth and Piatt<sup>27</sup> had applied the name Independence limestone to this same formation. It appears, however, that the name was previously used by Calvin<sup>28</sup> for a division of the Devonian shales in the vicinity of Independence, Iowa, and its use must, therefore, be abandoned by this Survey. The name Drum limestone is therefore adopted.

**CHANUTE SHALES.**<sup>29</sup>—The term Chanute shales is used to designate the shale-bed lying first above the Drum limestone and first below the Iola limestone. This name was introduced by Haworth and Kirk in 1894 in a preliminary publication, as already explained, at a time when a number of geological sections were run across the state. In that instance, local names were given to each formation under each section. Later, when a system of correlation was introduced, some of these names

24. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 36, Washington, 1903.

25. Haworth, Prof. E., Kan. Univ. Geol. Surv., vol. III, p. 47, Lawrence, 1898.

26. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 37, Washington, 1903.

27. Haworth & Piatt, Kan. Univ. Quart., vol. II, p. 115, Lawrence, 1894.

28. Calvin, Amer. Jour. Sci., 3d series, vol. XV, pp. 460-462, 1879.

29. Haworth & Kirk, Kan. Univ. Quart., vol. II, p. 109, Lawrence, 1894.



had to be dropped. It was found that the name Chanute shales was applied to the same formation in one section that the name Thayer shales was applied to in another. In volume III of this series of reports, page 49, it was decided to drop the term Chanute shales and retain the term Thayer shales, as it had been introduced at the same time. One of them necessarily had to be dropped, and the question of priority in no way entered into the question.

Subsequently, Adams,<sup>30</sup> in a government publication, restored the name Chanute shales, apparently under the impression that priority demanded it, and the term has been used since then by at least two different governmental publications. At present, therefore, we are forced to decide between the use of the term Chanute as employed by our government upon the advice of Adams, and Thayer, as previously employed by this Survey. As just explained, it is not a question of priority, the two being introduced at the same time and in a similar manner by Haworth and Kirk. The frequency of usage, however, is in favor of the governmental publications, and we bow, therefore, to the greater power and use the name Chanute.

**IOLA LIMESTONE.**<sup>31</sup>—The name Iola limestone is here used to designate the large and prominent limestone lying first above the Chanute shales. It was first introduced by Haworth and Kirk in 1894, and has been used continuously and without question by every one writing on the geology of this part of the state from that time to the present.

**LANE SHALES.**<sup>32</sup>—The term Lane shales was applied by Haworth in 1895 to the bed of shales first above the Iola limestone, and is here used with the same significance. In those early days, before positive correlations were possible, there was a little doubt as to its exact limitations. At present such doubt is all removed, and, therefore, its exact position may be given as a shale-bed lying between the Iola limestone below and the Allen limestone above.

Adams<sup>33</sup> has entirely ignored the use of this name, although it had been in good standing for ten years. In his report on the Iola quadrangle, he used in its place the name Concreto, probably in allusion to the manufacture of Portland cement at Iola. Why such disregard for well-established usage he does

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30. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 38, Washington, 1903.

31. Haworth & Kirk, Kan. Univ. Quart., vol. II, p. 109, Lawrence, 1894.

32. Haworth, Prof. E., Kan. Univ. Quart., vol. III, p. 277, Lawrence, 1895.

33. Adams, Dr. Geo. I., U. S. G. S. Bull. 238, p. 20, Washington, 1903.

not mention, and it is not known by the present writers whether it was his volition or a mandate from the committee on nomenclature of the United States Geological Survey.

ALLEN LIMESTONE.<sup>34</sup>—The name Allen limestone is here used to designate the limestone first above the Lane shales. There has been a large amount of discussion regarding the names of the two limestones first above the Lane shales. In its early work, this Survey was lead into error a number of times on account of a lack of proper correlation. After Adams<sup>35</sup> joined the United States Geological Survey, he likewise was incorrect in treating this subject. All along it has been known that there were two principal limestone formations, moderately close together and sufficiently persistent to mark a prominent escarpment across the state. In 1894 these two were not differentiated, and in the section of the Neosho river were called the Burlington limestone by Haworth and Kirk. In the same publication, in a section from Coffeyville to Lawrence, Haworth recognized a limestone at Carlisle, which he named Carlisle, and the two limestone masses at Garnett and Ottawa, which he named the Garnett limestone.

In volume II of the State Survey the term Garnett was used, Bennett having previously determined by field-work that the exposure at Carlisle was the lower of these two. In that way the name Carlisle was dropped. Adams decided that the lower member, or possibly both of these, was the limestone mentioned by Swallow as the Stanton limestone. Later, in United States Geological Survey Bulletin No. 238, whether voluntarily or not we do not know, he abandoned the term Stanton and introduced the terms Allen and Piqua for these two limestone-beds.

Our investigations have shown conclusively that the limestone named the Stanton limestone by Swallow in his report for 1866 is the upper one of these two much-discussed limestone formations. Inasmuch as we are now ready to give detailed descriptions and detailed names, we adopt the name Allen for the lower one of the two, because it seems to be the first name suggested for this specific formation, and retain the name Stanton for the upper one, because Swallow suggested it as early as 1866. Our former name, Garnett, may be used, should it be desired, for the combination of the two, as originally understood, but Adams's name, Piqua, for the upper

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34. Adams, Dr. Geo. I., U. S. G. S. Bull. 238, p. 20, Washington, 1904.

35. Adams, Dr. Geo. I., U. S. G. S. Bull. 238, p. 20, Washington, 1904.

one of the two must give way to Swallow's Stanton unless priority be entirely ignored.

VILAS SHALES.<sup>36</sup>—The name Vilas shales is used to designate the shales lying just above the Allen limestone and below the Stanton. When it was first named by Adams its exact position was not known, and yet Adams was correct in giving its location. The error consisted in a wrong discussion of the limestones. Adams thought that the Iola limestone extended south-westward, capping the hills at Neodesha, and that, therefore, the Vilas shales lay under the Iola. In this particular area he mistook the Allen for the Iola. This error followed him in all of his publications, even to his latest map of the Iola quadrangle, United States Geological Survey Bulletin No. 238. The shale-bed about Vilas to which he attached the name is now known to lie on top of the Allen limestone, forming a narrow zone extending practically across the state.

STANTON LIMESTONE.<sup>37</sup>—The name Stanton limestone is used to designate the limestone first above the Vilas shales. Swallow gives its locations as follows: "This limestone is well exposed in the eastern bluff of the Marais des Cygnes, in the highest points north of 'The Devil's Backbone,' above Stanton." There can be no doubt, therefore, regarding his exact use of the term at this place. However, he may have been led into error in correlating it with other limestones in other parts of the state. This is the same limestone formation named Piqua by Adams,<sup>38</sup> as has been abundantly proved by the most careful field-work.

#### DOUGLAS STAGE.<sup>39</sup>

The Douglas stage is divided into the following subdivisions, namely, Le Roy shales, Kickapoo limestone, Lawrence shales, and Oread limestone.

LE ROY SHALES.<sup>40</sup>—The name Le Roy shales is used to designate the shales first above the Stanton limestone and first below the Kickapoo limestone. In 1894 Haworth and Kirk recognized them in their section along the Neosho river. Later they were supposed to be correlated with the Lawrence shales, so well exposed farther north. In those days of imperfect correlation it was difficult to determine just what were their equiva-

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36. Adams, Dr. Geo. I., Kan. Univ. Geol. Surv., vol. III, p. 51, Lawrence, 1898.

37. Swallow, Dr. G. C., Geol. of Kan., p. 75, Lawrence, 1866.

38. Adams, Dr. Geo. I., U. S. G. S. Bull. 238, p. 20, Washington, 1904.

39. Haworth, Prof. E., Kan. Univ. Geol. Surv., vol. III, p. 93, Lawrence, 1898.

40. Haworth & Kirk, Kan. Univ. Quart., vol. II, p. 110, Lawrence, 1894.

lents north and south. We are now able to say that they have a sufficient existence to warrant a separate name.

**KICKAPOO LIMESTONE.**<sup>41</sup>—The name Kickapoo limestone is here used to designate a thin limestone found entirely across the state, from the state line in Chautauqua county northward to Doniphan county beyond Atchison. It is not very important, except at the northern outcrop, and had been overlooked in a measure in our earlier field-work. On account of its persistence, however, throughout a distance of 200 miles, its importance is readily recognized. It is the Willow Creek limestone described by Schrader<sup>42</sup> in his description of the Independence quadrangle area.

**LAWRENCE SHALES.**<sup>43</sup>—The Lawrence shales are so named by Haworth on account of the good exposure at the city of Lawrence, and to the south of that place.

**OREAD LIMESTONE.**<sup>44</sup>—The name Oread limestone, given by Haworth, is used for the limestone just above the Lawrence shales. The name was given on account of the limestone capping the hill known as Mount Oread, on which the University of Kansas stands, and has been continuously used by this Survey since its introduction. There are three members of this limestone, which, for detailed description, should be separated, but physiographically they appear as one, capping the prominent escarpment stretching entirely across the state.

#### SHAWNEE STAGE.<sup>45</sup>

The Shawnee stage is divided into eight subdivisions, namely, Kanwaka shales, Lecompton limestone, Tecumseh shales, Deer Creek limestone, Calhoun shales, Topeka limestone, Severy shales, Howard limestone.

**KANWAKA SHALES.**<sup>46</sup>—These shales are so named by Adams, and they occupy the interval between the Oread and Lecompton limestones. They were named for a township in Douglas county, where they have an outcrop.

**LECOMPTON LIMESTONES.**<sup>47</sup>—This name was given to these limestones by Bennett. They are named from the town which

41. Bennett, Rev. John, Kan. Univ. Geol. Surv., vol. I, p. 61, Lawrence, 1896.

42. Schrader, Dr. F. C., & Haworth, Prof. E., U. S. G. S. Bull. 296, p. 12, Washington, \_\_\_\_\_.

43. Haworth, Prof. E., Kan. Univ. Geol. Surv., vol. I, p. 136, Lawrence, 1896.

44. Haworth, Prof. E., Kan. Univ. Quart., vol. II, p. 123, Lawrence, 1894.

45. Haworth, Prof. E., Kan. Univ. Geol. Surv., vol. III, p. 93, Lawrence, 1898.

46. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 45, Washington, 1903.

47. Bennett, Rev. John, Kan. Univ. Geol. Surv., vol. I, p. 116, Lawrence, 1896.

was at one time the territorial capital of what is now the state of Kansas. They lie immediately above the Kanwaka shales.

**TECUMSEH SHALES.**<sup>48</sup>—The Tecumseh shales are so named by Beede. They fill the interval between the Lecompton and the Deer Creek limestones.

**DEER CREEK LIMESTONES.**<sup>49</sup>—Bennett named these limestones from their location on Deer Creek, east of Topeka.

**CALHOUN SHALES.**<sup>50</sup>—This name was introduced by Beede, and is applied to a shale above the Deer Creek and below the Topeka limestones.

**TOPEKA LIMESTONES.**<sup>51</sup>—The Topeka limestones are so called by Bennett. They are a quadruple series, and have been extensively quarried for building purposes at Topeka, from which place they derive their name. They lie immediately above the Calhoun shales.

**SEVERY SHALES.**<sup>52</sup>—The name Severy shales was applied by Adams to the outcrop bounded by the Topeka limestone below and the Howard limestone above. The town of Severy, from which the name was taken, rests on these shales. The name Osage City shales was given to this formation, but the name Osage having been preoccupied, Severy will stand.

**HOWARD LIMESTONE.**<sup>53</sup>—The name Howard limestone was given by Adams. It lies just above the Severy shales and caps an escarpment somewhat persistent from Valley Falls, in Jefferson county, to the south side of the state. It lies a few feet above the coal at Scranton, Carbondale, Osage City, and Topeka.

**SCRANTON SHALES.**—This name was proposed by Bennett in 1907 to the shale-bed lying between the Howard and the Burlingame limestones. Haworth, Hall and Adams called them the Burlingame shales, but the same name also was given to the Burlingame limestone at the same time, and therefore the name Scranton is now applied to these shales.

#### WABAUNSEE STAGE.<sup>54</sup>

The Wabaunsee stage is divided into eight subdivisions, namely, Burlingame limestone, Olpe shales, Emporia lime-

48. Beede, Dr. J. W., *Trans. Kan. Acad. of Sci.*, vol. XV, p. 28, 1898.

49. Bennett, Rev. John, *Kan. Univ. Geol. Surv.*, vol. I, p. 117, Lawrence, 1896.

50. Beede, Dr. J. W., *Trans. Kan. Acad. of Sci.*, vol. XV, p. 29, Lawrence, 1896.

51. Bennett, Rev. John, *Kan. Univ. Geol. Surv.*, vol. I, p. 117, Lawrence, 1896.

52. Adams, Dr. Geo. I., *Kan. Univ. Geol. Surv.*, vol. III, p. 66, Lawrence, 1898.

53. Adams, Dr. Geo. I., *Kan. Univ. Geol. Surv.*, vol. III, p. 67, Lawrence, 1898.

54. Prosser, Prof. C. S., *Jour. Geol.*, vol. III, p. 688, Chicago, 1895.

stone, Admire formation, Americus limestone, Elmdale formation, Neva limestone, and Eskridge shales.

**BURLINGAME LIMESTONE.**<sup>55</sup>—The name Burlingame was given to this limestone by Hall. It caps what is known as the Burlingame escarpment, and lies immediately above the Scranton shales.

**OLPE SHALES.**<sup>56</sup>—These shales were named by Adams from a little village by that name in the southern part of Lyon county, and is used to designate the shales between the Burlingame and Emporia limestones.

**EMPORIA LIMESTONE.**<sup>57</sup>—This name is applied by Kirk, and designates the limestone above the Olpe shales. They are described by Smith<sup>58</sup> as follows: "Passing up the bluff 75 feet at Humphrey's ford, we find above the Burlingame limestone 9 feet of yellow and blue shales, 1 foot of limestone, 11 feet of shales, 7 feet friable limestone which is overlaid in places with a mass of excellently preserved specimens of *Streptorhynchus crinistria*, 13½ feet of blue and yellow shale calcareous in places, 3 feet hard blue limestone with a seam 6 inches from the top. This stone I have designated the Emporia Blue. The 6-inch top layer makes a good quality of flagstone, which is extensively used in Emporia. Above this is 4 feet of slaty shale and another hard blue limestone agreeing paleontologically and lithologically with the one below."

**ADMIRE FORMATION.**<sup>59</sup>—The Admire formation was named by Adams. As before, Prosser<sup>60</sup> quotes from Smith<sup>61</sup> and says of this formation that its thickness is about 300 feet.

**AMERICUS LIMESTONE.**<sup>62</sup>—Haworth and Kirk named this the Americus limestone on account of its exposure and the quarries in it at that place. It lies just above the Admire formation.

**ELMDALE FORMATION.**<sup>63</sup>—This is so named by Prosser and Beede. It is exposed east of the town from which it takes its name and occupies the space between the Americus limestone below and the Neva limestone above.

55. Hall, John G., Kan. Univ. Geol. Surv., vol. I, p. 105, Lawrence, 1896.

56. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 52, 1903.

57. Kirk, M. Z., Kan. Univ. Geol. Surv., vol. I, p. 80, 1896.

58. Smith, Alva J., Bull. Lyon Co. Geol., p. 2, 1902.

59. Adams, Dr. Geo. I., U. S. G. S. Bull. 211, p. 53, 1903.

60. Prosser, Dr. C. S., Jour. Geol., vol. X, p. 107.

61. Smith, Alva J., Geol. of Lyon Co., p. 3, 1902.

62. Kirk, M. Z., Kan. Univ. Geol. Surv., vol. I, p. 80, 1896.

63. Prosser, Dr. C. S., & Beede, Dr. J. W., Jour. Geol., vol. X, No. 7, p. 708.

NEVA LIMESTONE.<sup>64</sup>—Prosser and Beede gave this name to this limestone, it being the name of a station of the Atchison, Topeka & Santa Fe railroad. It lies immediately above the Elmdale formation.

ESKRIDGE SHALES.<sup>65</sup>—From large exposure of these shales near Eskridge, the name was given by Prosser and Beede. It fills the interval between the Neva limestone and the Cottonwood limestone.

#### COUNCIL GROVE STAGE.<sup>66</sup>

The Council Grove stage is subdivided into two parts, namely, the Cottonwood limestone and the Garrison formation.

COTTONWOOD LIMESTONE.<sup>67</sup>—The name Cottonwood limestone or Cottonwood Falls limestone is a commercial term used by the trade for an indefinite period before it was applied to a definite geologic horizon. Extensive stone-quarries were opened up in the vicinity of Cottonwood Falls and stone shipped to many places for erecting costly buildings. In the summer of 1893, Haworth and Kirk made a geologic section up the Neosho and Cottonwood rivers. Their first report was published in January, 1894, and the name Cottonwood Falls limestone formally given to their number 13 of this section. Later, in 1894, Prosser<sup>68</sup> introduced the term "Cottonwood formation," including the Cottonwood Falls limestone and the overlying shale-bed. For the limestone he used the word "Cottonwood" rather than Cottonwood Falls, and in a number of publications since that date has adhered to the name Cottonwood. To simplify matters, therefore, this Survey, in volume III, used the word Cottonwood, which was considered unobjectionable, as the change was so little, and particularly as the commercial name was used indiscriminately, either Cottonwood or Cottonwood Falls. In 1902, Prosser<sup>69</sup> suggested the name Alma limestone instead of Cottonwood limestone, on account of the name Cottonwood being previously used by N. F. Drake in connection with Texas geology. In a letter, however, to Mr. Bennett, in 1907, Professor Prosser states that "Cottonwood or Cottonwood Falls would be the correct nomenclature." We are not informed of the details for Professor Prosser changing

64. Prosser & Beede, *Jour. Geol.*, vol. X, No. 7, p. 709, 1902.

65. Prosser & Beede, *Jour. Geol.*, vol. X, No. 7, p. 709, 1902.

66. Prosser, Dr. C. S., *Jour. Geol.*, vol. X, p. 709, 1902.

67. Haworth & Kirk, *Kan. Univ. Quart.*, vol. II, p. 112, Jan., 1894.

68. Prosser, Dr. Chas. S., *Jour. Geol.*, vol. III, p. 697, 1895.

69. Prosser, Dr. Chas. S., *Jour. Geol.*, vol. X, p. 711, 1902.

his mind as shown by this letter. The commercial use of the name Cottonwood is so extensive this Survey would be entirely powerless in making a change from Cottonwood to Alma were we to attempt it. Therefore we will continue the use of the name Cottonwood.

**GARRISON FORMATION.**<sup>70</sup>—The Garrison formation, so named by Prosser, fills the interval between the Cottonwood and the Wreford limestone and consists of two members, the Florina shales and the Neosho member.

**FLORINA SHALES.**<sup>71</sup>—The name Florina was given by Prosser and Beede, and was taken from the exposure over the Cottonwood limestone in the quarries near Florina, in the Big Blue valley.

**NEOSHO MEMBER.**<sup>72</sup>—This is so called by Prosser. He says: "This member was originally termed the Neosho formation, from the excellent outcrop in the Neosho valley near Council Grove. The Florina shales and the Neosho member are now united to form the Garrison formation, on account of good exposures from Garrison south in the Blue valley.

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70. Prosser, Dr. C. S., Jour. Geol., vol. X, No. 7, p. 712, 1902.

71. Prosser, Dr. C. S., Jour. Geol., vol. X, No. 7, p. 712, 1902.

72. Prosser, Dr. C. S., Jour. Geol., vol. III, p. 764, 1895.